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V CEPHALOPODS

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The cephalopods (squids, cuttlefish and octopi) are exclusively marine molluscs. These are commercially important and are fished in large quantities in several countries. The average annual world catch of cephalopods during the period 1963-1969 was 901 thousand tonnes which is about 30% of the average total world mollusc production of 2,971 thousand tonnes for the same period (Table VI). Represented by over 650 species (Choe, 1966), cephalopods occur in all the oceans of the world, and are distributed from shallow inshore areas to deep oceanic waters. They widely range in size from tiny sepiolids to giants like *Architeuthis* sp. which grow to a size of over 60 feet in total length. They provide food for man and form part of the diet of animals such as whales, seals, oceanic birds and certain valuable food fishes.

Cephalopods are caught in seas around India in fair quantities, but largely incidentally in nets that are operated for other commercial fishes, almost all through the year. Several species have been reported but to mention a few of the commonly occuring cephalopods are *Sepia pharaonis* Ehrenberg, *S. aculeata* Ferussac & d'Orbigny, *S. thurstoni* Adam & Rees, *S. brevimana* Steenstrup and *Sepiella inermis* (Ferussac & d'Orbigny) among cuttlefish, *Sepioteuthis arctipinnis* Gould, *Loligo duvauceli* d'Orbigny, *Loligo hardwickii*, *Loliolus investigatoris* Goodrich and *Euprymna stenodactyla* Grant among squids and *Octopus dollfusi* Robson, *O. rugosus* (Bosc), *O. globosus* Appellöf, *O. herdmani* Hoyle and *O. hongkongensis* Hoyle among octopi (Rao, 1958; Silas, 1968).

At the present time utilization of cephalopods as food is very limited in India. Only the coastal dwelling people have taken advantage of these nutritious items and the people of interior places are not much familiar with the shellfish. Our annual average cephalopod catch for the period 1959 to 1969 is estimated to be only 523 tonnes. This figure appears to be far below the exploitable resources of our seas. Apart from the above listed common littoral species, the recent exploratory surveys and planktological investigations conducted off the west coast and in the Laccadive sea have brought to light the availability and distribution of many potentially important oceanic squids and cuttlefish (Silas 1968, 1969; Silas and Sarvesan, 1968). The oceanic squids constitute the hitherto untapped resources of the seas around India. They are chiefly members of the family Ommastrephidae, the most important of them being *Symplectoteuthis oualaniensis* (Lesson) which is abundantly distributed in the northern and central parts of the Indian Ocean (Filippova, 1968).

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TABLE VI

World catches of marine invertebrates for the period 1963 to 1969. Figures indicate landings of live weight in thousand tonnes (Source: F. A. O. 1969a, 1970a).

Years	Crustaceans, molluscs and other invertebrates.	All molluscs	Cephalopods	Cephalopod catches expressed as percentages of total molluscan catches
1963	4090	2924	959	32.8
1964	3847	2646	624	23.6
1965	4049	2830	844	29.8
1966	4219	2911	824	28.3
1967	4456	3065	938	30.6
1968	4761	3325	1168	35.1
1969	4535	3101	950	30.6
Average	4279	2971	901	30.3

There are a few works available on the systematics of Indian cephalopods in which technical descriptions of all the common species are found (Goodrich, 1896; Massy, 1916; Adam, 1938 and 1939, Adam and Rees, 1966; Gravely, 1941; Satyamurti, 1956). Key to the field identification of the different genera of cephalopods to which the common species belong is given below. The external and the more familiar internal characters are utilized for distinguishing them.

1. Cephalopods with eight circumoral arms, without tentacles; arm suckers arranged in two rows, without horny rings and stalks. Third arm tip of male spoon-shaped (hectocotylized) ..... (Octopodidae) *Octopus.*

   Cephalopods with ten arms eight being short and circumoral and two slender and tentacular. Suckers of the arms and tentacles stalked and equipped with armature. 2

2. Shell (cuttlebone) internal calcareous in nature, body ovoid and dorso-ventrally somewhat flattened. Fins narrow, marginal in position and extending on either side along the entire length of the mantle, not uniting at the end. Arms with mostly quadriserial suckers ... (Sepiidae) 3

   Shell (gladius or pen) internal but chitinous in nature. Body cylindrically elongate. Fins either terminal or marginal in position uniting at the apex of the mantle 4

3. Cuttlebone broadly oval in shape and with a spine at the posterior end. The mantle without a glandular pore at the posterior extremity ..... *Sepia* (*S. aculeata* Fig. 7 A and *S. pharaonis* Fig. 6 A)

   Cuttlebone smaller in size, oval in shape and devoid of the spine. The mantle bears a small but distinct glandular pore at the posterior extremity... *Sepiella* (*Sepiella inermis* Fig. 7 C, D, E)

4. Fins triangular or rhomboidal in shape, restricted to the posterior margin of the mantle.....*Loligo* (*Loligo duvauceli* Fig. 5 C)

   Fins broad and extending almost to the entire length of the mantle ..... *Sepioteuthis* (*Sepioteuthis arctipinnis* Fig. 5 A)

COMMERCIALLY IMPORTANT CEPHALOPODS

Very little is known about the fishery and biology of Indian cephalopods. Hornell (1917, 1922 and 1951c) has given a general account of the fishery of Palk Bay squids and octopus in Ramand district in Tamil Nadu. Rao's (1954) work on the biology and fishery of the Palk Bay squid, *Sepioteuthis arctipinnis* is the only detailed study of its kind available on the cephalopods of this country.

SQUIDS

Squids belong to the order Teuthoidea (Decapoda) which includes the majority of cephalopods, possessing a stream-lined soft body with a pair of fins varying in shape, size and disposition. The distinct head in front is with ten circumoral arms provided with toothed suckers or claws or both. An internal shell known as pen or gladius, when present is imbedded in the dorsal mantle skin. The gladius of squids is almost transparent, thin and chitinous in nature. It varies in shape in different species. Squids exhibit enormous power of swimming and their swift progression through water is effected by the combined action of the mantle and the specialized structure called siphon or funnel situated on the ventral side. Such fast moving squids are distributed from shallow to varying depths of all oceans.

SEPIOTEUTHIS ARCTIPINNIS Gould

COMMON NAMES

Tamil–*Ekkikanavai, Kundal kanavai*

Sepioteuthis arctipinnis is a common Indo–Pacific species. In India this is widely distributed but large concentrations are confined to the south–eastern coast especially the Palk Bay and Gulf of Mannar. This particular species is readily distinguished from all other squids by the presence of very wide and long fleshy

fins extending almost the entire length of the mantle and the presence of chitinous pen. The following description of the species and account of its biology is based on the work of Rao (1954).

DESCRIPTION

The mantle is elongate, conico–cylindrical in outline, tapering to a blunt point behind; anterodorsally the mantle extends over the nuchal region into a round point, and anteroventrally below the funnel it bears a deep emargination; fins, attached on either side traversing almost all along the entire length, are large, thick and muscular; the fins are narrow in front, gradually widening behind and broadest about the posterior third of the body beyond which they narrow down rapidly and meet each other at the posterior extremity; head slightly narrower than the body; eyes large and prominent; funnel large, broadest at the base and provided with a valve (Fig. 5 A).

Arms unequal in length in the order 3=4.2.1. the second and third pair of arms are prominently keeled; suckers of all arms are arranged in two alternating rows; the horny rings of the suckers equipped with teeth on their outer margins; In the males the left ventral arm is hectocotylized by the modification of suckers and pedicles of the distal half of the arm. Proximally there are about 20 normal suckers followed by 6 pairs of enlarged pedicles with smaller suckers. Beyond this, on the distal portion of the arm, suckers are absent and the pedicles are enlarged into fleshy conical papillae; dorsal row of pedicles slightly larger than the ventral rows.

Tentacles moderately long and the stalks are slightly laterally compressed; tentacular clubs large and provided with trabeculate protective membranes on the sides. The club suckers are quadriserially arranged, suckers of medial rows larger than those of the margial rows; chitinous rings of the club suckers are denticulate.

Mouth surrounded by seven lappets; the tips of the lappets possess minute suckers with horny rings having about 25 blunt teeth. The gladius is chitinous and lanceolate in shape and colourless (Fig. 5 B). The colour of the animal is whitish in fresh condition with greenish tinge surrounding the eyes. Chromatophores present all over the body excepting the ventral surface of fins. On the dorsal surface of the mantle and fins grey coloured transverse streaks are found which are distinct in males.

Fig. 5. A. *Sepioteuthis arctipinnis* Gould Dorsal view of male. B. Gladius of *S. arctipinnis*. C. *Loligo duvauceli* d' Orbigny Dorsal view of female. D. Gladius of *L. duvauceli*.

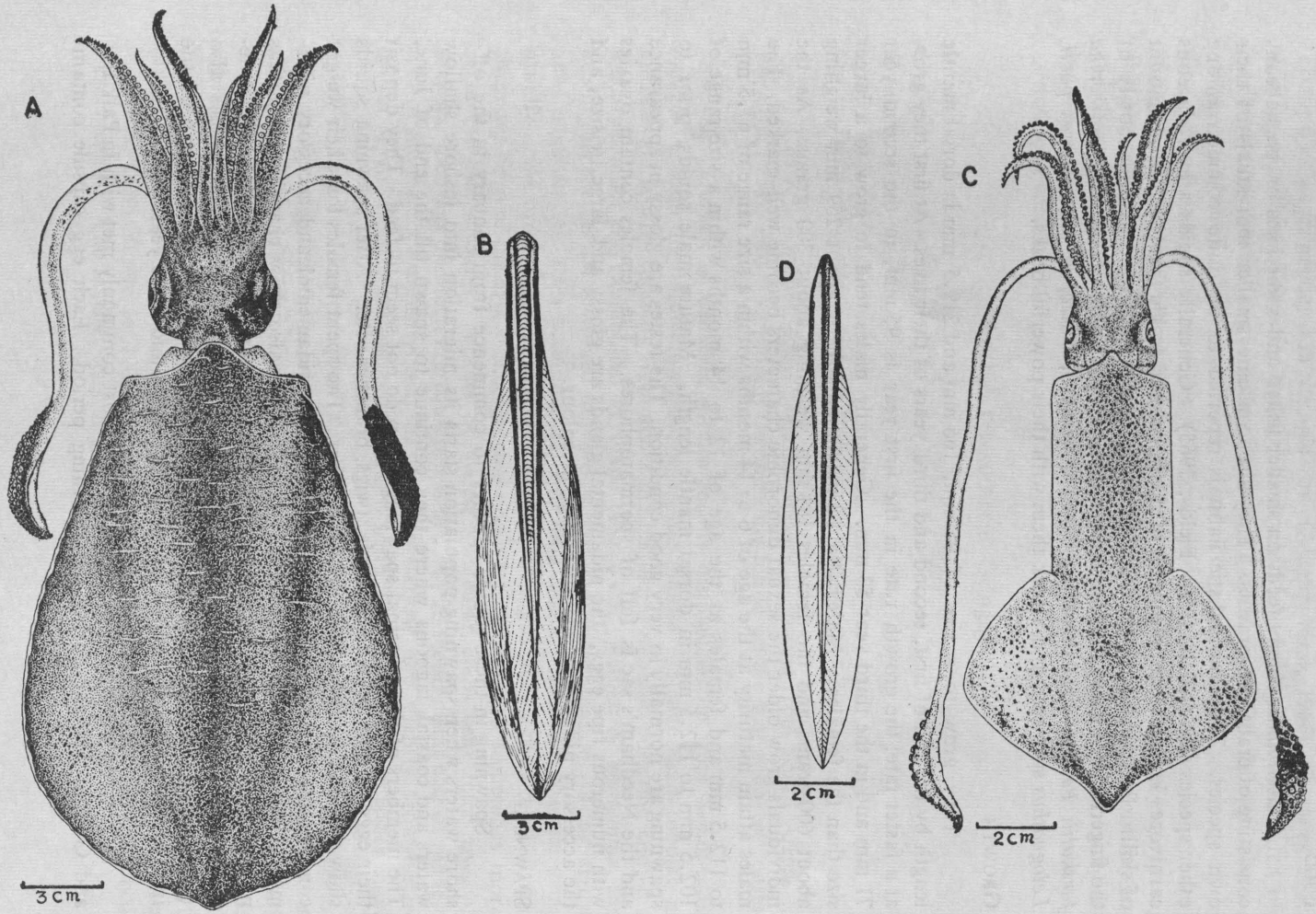

Fig. 5

FOOD

S. arctipinnis chiefly feeds on smaller fishes and sometimes on crustaceans consisting of crabs and prawns. They also consume smaller individuals of their own species. The cannibalistic habit is reported to be quite common among other species also (Allan, 1950; Fields, 1965). Generally squids are predaceous carnivores known to go in pursuit of their prey and tackle them with good amount of skill. Presumably, *S. arctipinnis* actively chases its prey consisting mostly of the fingerlings of fishes like *Sardinella* spp., *Syngnathoides bimaculatus, Atherina forskalii, Pelates quadrilineatus, Upeneus vittatus, Therapon puta, Gerres poeti, Leiognathus* spp. etc., and attack them with their powerful beaks.

GROWTH

They grow to a size of 95 mm, 166 mm and 219.5 mm in dorsal mantle length by the end of first, second and third years of their lives. At first they grow at a faster rate; the growth rate in the first year is 95 mm, in the second year 71 mm and in the third year 53 mm. Generally males tend to grow to a larger size than the females. Males attain a maximum size of about 259 mm weighing about 600 grams and the females 181 mm weighing about 300 grams. As the individuals grow older the sexual dimorphic characters become well-marked. The males attain maturity at the age of 6 to 14 months within a size range of 67.5 mm to 112.5 mm and females at the age of 12 to 14 months within a size range of 102.5 mm to 112.5 mm in dorsal mantle length. Mature male squids, prior to spawning are normally in very good condition. The testes are glossy in appearance and the Needham's sac is full of spermatophores. The females contain ovaries with numerous ripe eggs, the nidamental glands are glossy and large in size, and the accessory nidamental glands orange in colour.

SPAWNING

Spawning in these squids appears to commence from January in the off-shore waters when spawning population starts its migration into inshore shallow waters and coastal lagoons where they continue to spawn till the end of June. The members of the principal spawning group do not seem to feed. They deposit their eggs on objects like sea weeds, twigs, branches etc. After spawning squids show tremendous changes in their condition. The spent females lose their weight considerably. their mantles become flaccid, the nidamental and accessory nidamental glands become thin and less glossy. Males also show changes but not as profound as in the case of females; their mantles and fins alone become somewhat limp. Such post-spawning changes are presented by other species also (McGowan, 1954; Fields 1965). In the case of *S. arctipinnis* the life span of the individuals is reported to be two years for females and three years for males.

The egg capsules of *S. arctipinnis* are most commonly met with in Palk Bay and Gulf of Mannar during the spawning period. Each egg capsule contains

about 6 to 7 eggs arranged in a single row (Alagarswami, 1966). It takes about a little more than 15 days for the eggs to develop into young ones and hatch out under normal conditions at a temperature range of 22 to 29° C. The just hatched young are about 7.5 mm in total length and 3.0 mm in width. The mantle of the tiny young is transparent and the well-developed visceral organs are clearly seen through the mantle. Chromatophores are present all over the body except on the ventral side of the fins. Remarkably, the just hatched young do not possess the characteristic broad fins but they are present in the posterior extremity of the mantle as a pair of small flaps. Normally they do not survive for prolonged period in aquarium.

LOLIGO DUVAUCELI d' Orbigny

(=*L. indica* Pfeffer)

COMMON NAME

Tamil – *Oosi kanavai, Oosi kadama, Nedurg kadama.*

This is a common Indo–Malayan species occurring from South Africa to Formosa (Voss, 1963). In India it is commonly found on the east and west coasts

L. duvauceli is a smaller species readily distinguishable from *Sepioteuthis arctipinnis* from the following characters : the mantle is slender and tubular in outline and tapers gradually from about the middle to a blunt posterior end; the fins are smaller and rhomboidal in shape (Fig. 5 C). Unlike *S. arctipinnis*, the fins in this species are restricted to the posterior end of the mantle. The narrow head possesses ten arms including the two long slender tentacles. Sessile arms usually in the order 3.4.2.1. in length; suckers arranged in two rows in all arms; chitinous rings of the arm suckers possess about 6 to 8 teeth and sometimes more as in the case of larger suckers of males; tentacular clubs bear four rows of suckers, the rings of which are equipped with 17 to 20 teeth; distal half of the left arm of the male is hectocotylized; the gladius is narrow and slightly brownish in colour (Fig. 5 D); the ink sac possesses two small light organs one on either side.

No published information is available on the biology of this squid. They are usually caught in shore seines, boat seines and largely in trawl nets almost all through the year from Cape Comorin to Calcutta on the east coast and all along the west coast. Although they are caught all round the year in varying amounts their abundance appears to be from May to September in the Palk Bay. The peak of the season appears to be from June to August when large heaps of them are regularly seen in the markets along with other squids and cuttlefish. The size ranges from 50 mm to 120 mm and occasionally around 160 mm in dorsal mantle length. The females tend to grow larger than the males.

Apart from the afore-mentioned species others are considered unimportant as they occur only in stray numbers or because they are not utilized as food. *Euprymna stenodactyla* is usually caught in shore seines in good numbers in early hours of the day. They are commonly preyed upon by fishes like carangids. *Loliolus investigatoris* is a smaller squid which is occasionally caught in good quantities in seines and trawl nets but they are used neither for food nor bait owing to their small size. *Symplectoteuthis oualaniensis* is a larger ommastrephid squid an oceanic species which is occasionally captured in drift nets from Palk Bay and Gulf of Mannar.

CUTTLEFISH

Cuttlefishes belong to the order Sepioidea. Like squids, they possess well-defined head and ten arms. They have a broad and flattened body with narrow fins running along the sides to the full length of the body. The arms are comparatively short and provided with subequal suckers mostly arranged in four transverse rows. The two long, slender tentacles are retractile into special pockets and used at the time of capturing the prey. The characteristic internal shell or the cuttlebone is calcified and differs in shape and size in different species.

They are only three of species of cuttlefish viz., *Sepia pharaonis*, *Sepia aculeata* and *Sepiella inermis* which occur widely in India.

SEPIA PHARAONIS Ehrenberg

(= *S. rouxii* Fèrussac and d'Orbigny)

This is the largest of species of cuttlefish found in our waters. Widely distributed in the Indo-Pacific it occurs all along the Indian coasts.

DESCRIPTION

The body of the cuttlefish is stout and oval in outline and widest at the anterior end. In front, the mantle is produced middorsally into a triangular lobe and midventrally slightly emarginated; fins very wide and fleshy and originate a few millimetres behind the anterior margin of the mantle; fins broad, extend along the periphery of the mantle and reach the posterior extremity; funnel large and thick walled, reaching almost to the base of the ventral arms; a triangular valve present in the funnel (Fig. 6 A).

The head is a little narrower than the mantle opening; mouth surrounded by seven buccal lappets, the edges of which are beset with minute suckers; arms subequal in length and attenuated; suckers arranged in four transverse rows on the arms and bordered by protective membranes; horny rings of the arm suckers have numerous palisaded teeth; tentacles long, thick and triangular in cross section; tentacular clubs are broad and fringed with strong swimming

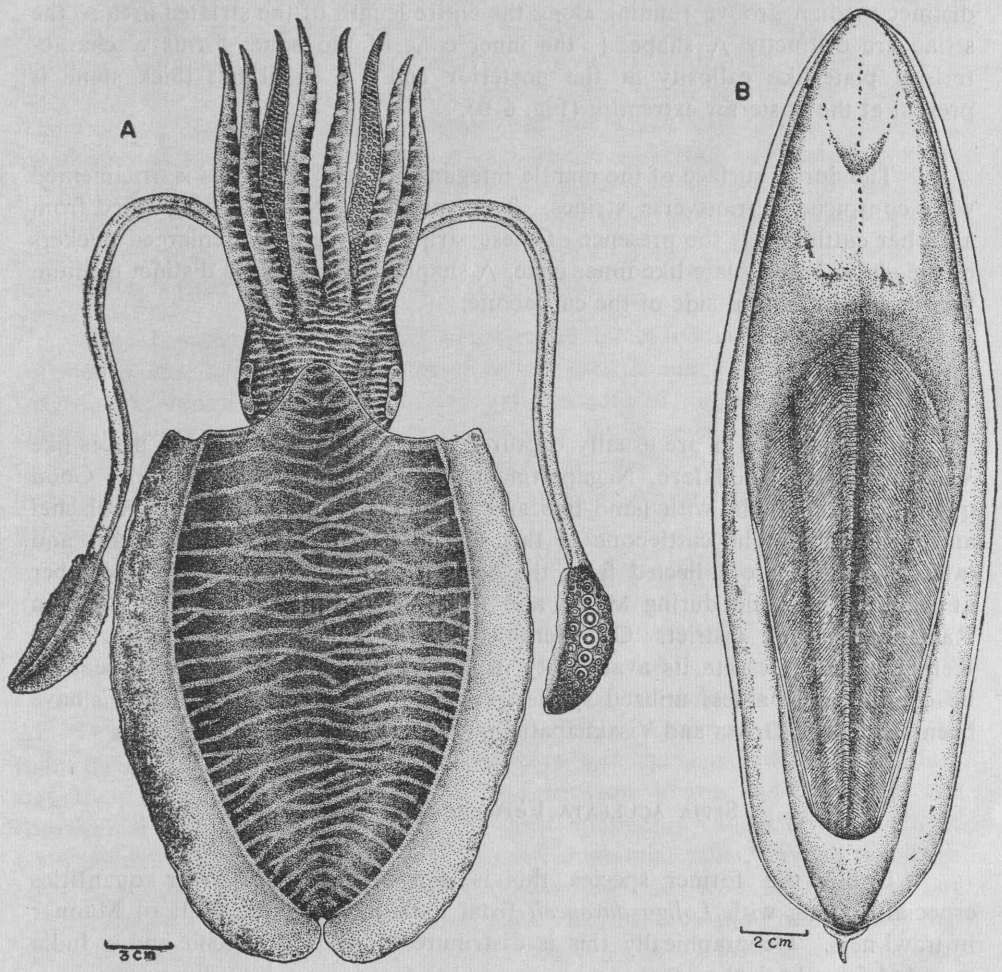

Fig. 6. A. *Sepia pharaonis* Ehrenberg Dorsal view. B. Cuttlebone of *S. pharaonis*.

membrane on the right side; there are about 113 unequal suckers arranged in five to seven oblique rows; of the suckers, two rows in the middle are greatly enlarged in about seven series, the seventh and the eighth from the base are exceedingly large; horny rings of club suckers smooth.

Cuttlebone is elongate and broadest at about the middle ; there are three low longitudinal ribs and broad chitinous margins on the dorsal surface ; ventral surface is concave posteriorly and convex anteriorly ; there is a shallow but distinct median groove running along the entire length of the striated area ; the striae are distinctly $\wedge$ shaped ; the inner cone of the bone forms a characteristic plate-like callosity at the posterior end ; a small but thick spine is present at the posterior extremity (Fig. 6 B).

The dorsal surface of the mantle integument, head and arms is ornamented with conspicuous transverse stripes. The species is readily distinguished from all other cuttlefish by the presence of these stripes on the body, enlarged suckers of the clubs, broad plate-like inner cone, $\wedge$ shaped striae and the distinct medium furrow on the ventral side of the cuttlebone.

Fishery

These cuttlefish are usually captured in small numbers in many places like Visakhapatnam, Cuddalore, Nagapattinam, Kilakarai and Rameswaram. Good quantities are caught with hand-line and scoop nets at Cape Comorin, Colachel and Vizhinjam. The cuttlebone of this species is commercially important and large quantities are collected from the beaches during November and December at Rameswaram and during March and April at Thiruppalakudi and Tondi in Ramanathapuram district. Considerable quantities are also collected from Kerala coast. Despite its availability in good abundance *S. pharaonis* seems to be commercially a less utilized species. Spawning grounds of *S. pharaonis* have been located off Orissa and Visakhapatnam (F.A.O./UN, 1961).

Sepia aculeata Fèrussac and d'Orbigny

Unlike the former species this is caught in much larger quantities especially along with *Loligo duvauceli* from Palk Bay and the Gulf of Mannar in trawl nets. Geographically this is distributed in the Indo-Pacific and in India reported from both the coasts.

Description

The mantle is roughly oval, broadest near the anterior end ; ventral margin of the mantle concave in the middle, middorsal projection has well-excavated sides ; fins narrow and originate a little behind the anterior margin of the mantle on the sides and extend to the end of the body where they are almost in contact with each other ; head narrower than mantle opening ; funnel short and does

not reach the base of the ventral arms; buccal lappets surrounding mouth are seven, with minute suckers at their extreme ends (Fig. 7 A).

Arms short and subequal in length; dorsal arms slightly rounded ventral arms provided with strong swimming membranes. Suction cups uniformly quadriserial on all arms and have dentate horny rings; ventral arm of the male is hectocotylized at the base; tentacles slender and relatively thinner than the sessile arms; tentacular clubs elongate but not much expanded; swimming membrane of the club very narrow; suckers are numerous and minute in size; the cuttlebone possesses a longitudinal mid-ventral ridge in the striated area and the striae are notched in the middle; the posterior inner cone is not plate-like but raised into a thick rounded ridge; there is a small spine at the posterior extremity which is slightly pointed upwards (Fig. 7 B).

The commercial catches are represented by individuals ranging in size between 50 mm and 150 mm in dorsal mantle length and 17 and 500 grams in weight. A preliminary analysis of the gut contents of the cuttlefish shows that chiefly fishes and crustaceans and occasionally polychaetes comprise the main items of diet. *S. aculeata* appears to breed biannually (Rahaman, 1967). The first period of breeding season extends from February to April and the second period between July and August.

SEPIELLA INERMIS (Fèrussac and d'Orbigny)

This species can be readily recognized by its smaller size, presence of a distinct minute pore at the posterior end of the mantle, and the absence of a spine in the cuttlebone. The cuttlebone is altogether different in shape (Figs. 7 C, D and E). Widely distributed in the Indian Ocean, from Red sea to Indonesia and Cochin-China it is reported from both the coasts of India (Adam and Rees, 1966). The species range in size between 40 mm and 55 mm in the commercial landings. Though they are quite commonly caught in trawl nets in good numbers they do not seem to have any commercial value. When caught in large quantities they are either used for bait or discarded from the catch but not used for food. Nevertheless, in some places like Madras and Pondicherry they are favoured as food but only by certain fishermen and poor classes of people, and are sold either at the landing centres or markets in fresh condition.

OCTOPI

Octopi belonging to the Order Octopoda, possess a short rounded body and a distinct head fringed with eight arms, which are provided with a broad interbrachial membrane. The saccular mantle lacks fins. The suckers, arranged in two rows, are without stalks and horny rings. The animals are solitary in habit and mostly live in shallows crawling on the bottom, often hiding themselves in the crevices among rocks. Crabs and bivalves form their favourite food and

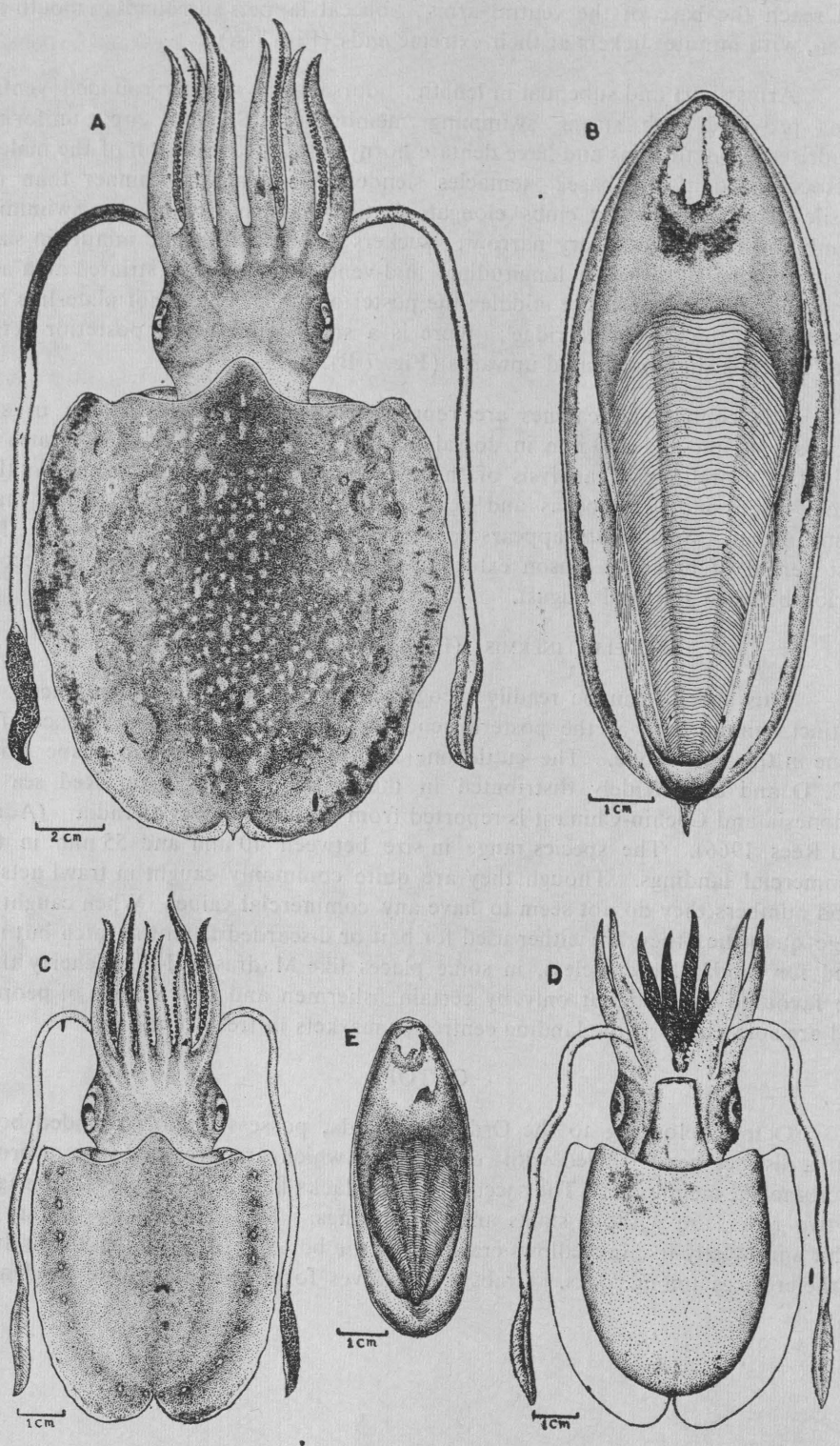

Fig. 7

smaller shrimps and fishes are also preyed upon by them. Several octopi are known to occur in Indian seas. *Octopus herdmani* Hoyle, *O. globosus* Appelöff, and *O. dollfusi* are the common shallow water forms of the Palk Pay and the Gulf of Mannar. No information is available on the biology of these octopi. They are called *pey kanavai* in Tamil. Octopi are well-known sea food in Japan and the people of countries like Spain, Italy and Philippines also relish octopi (Araya, 1967). Octopus is not much liked as food in India, excepting by those who are accustomed to eating it. In the Laccadives octopi are sought for being used as food and regular 'octopus hunting' is pursued. Their use as bait is widespread in the south-eastern coast of India. A number of octopi are caught in specially devised shell traps exclusively for bait in hook and line fishery especially along the Palk Bay (Hornell, 1917). A smaller species of Octopus locally called *sangu kanavai* is largely caught in this bait fishery. Octopi usually thrive well in capitivity. Preliminary observations on *O. dollfusi* show that they lay their eggs in festoons. They brood over the developing eggs with good amount of care till they hatch. Generally it takes about two weeks for the eggs to hatch out. The just hatched young range in size between 3.3 and 3.8 mm in mantle length.

The common species of octopus which usually abound on the pearl banks is *Octopus herdmani* Hoyle. Considerable damage is inflicted by these octopi upon pearl oysters by preying upon them. Many instances of *O. herdmani* predating on young oysters have been reported (FAO/UN, 1960). Another small, slender octopus locally known as *visha kanavai* (poisonous octopus) is said to be dangerous owing to its poisonous bite and they are never used as bait or food. When encountered in nets it is usually discarded immediately. Otherwise it tries to fasten on the limbs and bite through the skin. The pain received from the bite is likened to the sting of a scorpion and if not treated immediately the limb will swell and a feeling of giddiness will be experienced and sometimes the effect lasts for several months.

METHODS OF FISHING

The squids, cuttlefish and octopi are captured by various means. In general they are caught incidentally along with other food fishes in shore seines, trawl nets, boat seines and cast nets. In special methods a knowledge of the behaviour of the particular form is also made use of for capture. The shoaling behaviour and the shoreward migration during the spawning of squids and cuttlefish are exploited in fishing.

In the inshore waters of Palk Bay a special type of shore seines called *ola valai* is used for the capture of squids exclusively *Sepioteuthis arctipinnis* from

Fig. 7 A. *Sepia aculeata* Fèrussac and d'Orbigny Dorsal view. B. Cuttlebone of *S. aculeata*. C. *Sepiella inermis* (Fèrussac and d' Orbigny) Dorsal view. D. *S. inermis* Ventral view. E. Cuttlebone of *S. inermis*.

April to June and to minor extent from October to November. The *ola valai* (*olai*, palm leaf; *valai*, net) is utilized for squid fishing during the peak of the season i.e., May to June in Rameswaram Island, Mandapam, Devipatnam and Tondi along Palk Bay and in certain places like Rameswaram, Pamban, Mandapam, Pudumadam, Periapatnam, Kilakarai and Muthupettai along the Gulf of Mannar. The details of squid fishing by this method has been described by Rao (1954). The *ola valai* consists of a close-meshed rectangular bag about 8 m × 2 m and wing ropes of about 270 m in length. The latter bear strips of palm-leaf along the length in three or four close-set rows near the wings and in a double or single row in the rest of the length. The mode of operation is like that of any shore seine. Leaving one of the wing ropes ashore, the net is set from a rowing boat in a semicircular way, with the opening of the net facing the shore, thereby encircling a school of squids that may be present. The other end of the wing rope is brought back to the shore and subsequently the net is hauled. The palm-leaf strips of the wing ropes are intended to entice the squids into the bunt of the net.

Throughout April and May when shoals of squids appear off Rameswaram, Mandapam, Tondi and Devipatnam the *ola valai* are operated regularly and large quantities are landed. Squids are obtained in Gulf of Mannar in shore seine catches throughout the year in small numbers.

During the peak of the season special squid jiggers were used previously for capturing squids and the larger species of cuttlefishes in the Palk Bay region as described by Hornell (1917). In this method a special Y-shaped pole called *machan* with a bar across the bifurcated branching of the pole is erected in shallow coastal areas. The *machan* is used as a look-out post by the fisherman who sits on the cross bar with a long jigger consisting of 5 to 6 hooks arranged in grapnell fashion. The hook-end of the jigger is hidden under a heap of leaves arranged near the machan as a lure for the squids. When female squids and males in pursuit of them approach the leaves for depositing eggs, they are lifted off water with a jerk movement of the jigger.

This once extensively used method is not practised now. At the present time squid jigging is followed in a modified way. When shoals are seen, fishermen especially at Devipatnam, Thiruppalakudi and Rameswaram go in canoes or catamarans equipped with jigger. The jigger consists of a 35 to 40 cms long sturdy wire furnished at one end with three or four strong hooks. The other end is tightly tied to a slender pole which serves as the handle. When squids move within the reach of the jigger fishermen cautiously hook them individually with a quick jerk of the jigger and haul them into the boat. In this manner a large number of them are caught in a day. Occasionally large species of cuttlefishes like *Sepia pharaonis* are also captured by this method when they are encountered.

The squid *Loligo duvauceli* and the cuttlefish *Sepia aculeata* are usually captured in shore seines and boat seines only in small numbers. Until the introduction of trawl fishing on the south-east coast and other parts of the country it was generally considered that they were less abundant. Now, with the use of mechanised vessels and extension of fishing to the offshore areas much higher yields of *Sepia aculeata* and *Loligo duvauceli* are regularly obtained. The season for these species lasts from March to August. Although available extensively throughout India, they are fished to a greater extent from the Palk Bay and Gulf of Mannar close to Mandapam and Rameswaram.

Baited hooks and scoop nets are employed to catch *Sepia pharaonis* occasionally at Vizhinjam, Colachel and Cape Comorin. Fishermen reach the fishing ground in catamaran trolling a hand-line consisting of baited hooks which serve as snare. The cuttlefish thus attracted by the bait are dragged near the catamaran by slowly raising the line and taken with scoop net. In this way considerable number of them are procured.

The octopi are captured by employing various methods. The techniques range from hunting with spear to fishing with traps. In Minicoy island men, boys and girls collect octopus called *appalu* in local language from the coral reefs with two thick iron rods during favourable tide. As soon as the octopus is spotted among the crevices or holes in coral reefs one of the sharp ends of the rods is thrust into the quarry forcibly and hauled with the help of another rod. The octopus is then killed by the widely practised method called ' turning the cap ' i.e, by pushing the viscera out through the mantle opening.

Another method of catching octopus is also used in the bait fishery in the coastal villages bordering Palk Bay particularly at Tondi and Thiruppalakudi. The octopi, especially *O. globosus* are captured in shell traps. The shell traps are made of indigenous materials such as empty sea shells, thin coir ropes and wooden floats. Empty molluscan shells, largely *Lambis lambis*, *Tonna dolium*, *Rapana bulbosa, Murex virgineus* and *Hemifusus* are utilized for making such lines. The finger-like projections of *Lambis lambis* are usually broken off before being used, 100 to 120 of these shells are strung along a thin coir rope each 15 to 20 cm apart. A number of such lines are laid at the bottom of the sea at four to six metres depth and the ends of the lines buoyed with large wooden floats. Such traps are raised daily by the fishermen and the small octopi *O. dollfusi* and *O. globosus* which take refuge in the hollows of the shells are extracted with a strong needle and utilized as bait. The shell traps are again laid at the same place for further use. After prolonged time of using the lines are periodically brought ashore and dried. The bait fishery is suspended during the rainy seasons.

It is of interest to mention briefly the methods that are employed in the

cephalopod fishery in other parts of the world. One of the most widely practised methods for capturing squids and cuttlefishes is jigging. The Japanese squid jigging method is very efficient for squid fishing. Jigging is the method by which the world's largest catch of cephalopods is fished by Japan. The jigger consists of hooks fixed with a lead weight at one end in a circular fashion or with a bait fish. The hooks are sometimes intensely coloured to attract squids. The jigger is lowered into the water either with or without bait and the squids which rush towards the jigger are captured with a hand net or the jigger is hauled quickly into the boat. Multiple mechanical jiggers are used at present in Japan (Araya, 1967).

The commercial squid fishing in California is carried out with lampara nets, Fishing is done during night by encircling the school of squids, attracted by lights, from the boat, and hauling into the boat by power lifted dip nets (Fields, 1950). With a view to avoid brailing and to reduce the crew required in this method of fishing, squid slurp has been recently experimented in California squid fishery in San Pedro (Anonymous, 1970).

PREPARATION OF THE CATCH FOR THE MARKET

Mostly squids and cuttlefish are sold in the markets in fresh condition and only limited quantities in dried condition. After capture the larger species of squids and cuttlefish are split open on the midventral plane to remove the ink sacs as otherwise the whole lot will become undesirably stained with the dark ink. Generally the ink sac of smaller species like *Loligo duvauceli* is not removed before being sent to the markets. At Mandapam where large quantities of *L. duvauceli* are caught in trawl nets the entire catch is loaded in baskets with crushed ice and sent to Ramnad and Kilakarai markets where they are sold in lots. Usually *Sepioteuthis* fetches a higher price than other cephalopods. The price varies aocording to the size from 25 ps. for smaller individuals to 75 ps. for larger ones. *Loligo duvauceli* and *Sepia aculeata* are sold in lots each consisting on an average of 4 to 6 numbers. Each lot varies in price from 25 ps. to 35 ps. at Ramnad market and fetches rather higher price at Kilakarai market where the local population very much relish them.

When the catches are enormous, as during the peak of the seasons, a small portion of them is cured. For this purpose *Sepioteuthis arctipinnis* and *Sepia pharaonis* are spilit open and the ink sac, viscera and the shell are removed on the field. To remove the shell a small slit is made at the anterior end of the dorsal side of the mantle and the shell is pulled out. The pigmented integument of the mantle is peeled off and the mantle is washed in sea water. Then the mantle appears whitish and attractive. Sometimes the head and the arms are also discarded and the mantle portion alone utilized. The mantles are sun-dried either with or without salt. On drying the product usually becomes a little hard.

In the case of smaller cephalopods like *Loligo duvauceli*, *Sepia aculeata* and *Sepiella inermis*, they are simply dried without washing and removal of shell and visceral components. Such crude product is inferior in quality and sold at relatively cheaper rate.

An improved method has recently been attempted in the Indo-Norwegian Project to process cuttlefish and squids. The new product developed is called 'fingers' of squids and cuttlefish. Iced squids and cuttlefish (*Loligo sp.* and *Sepia aculeata*) are used to manufacture these. The raw materials are well washed in bacteriologically pure and chlorinated water and the cuttlebone and outer chromatophoric layer of mantle are removed. The mantles of the squids and cuttelfishes are then cut into uniform strips each measuring about 2 to 2·5 cm. in thickness and suitable size. The resulting 'fingers' are packed in cartons which are lined with a sheet of polythene. The cartons thus packed are quick frozen at a temperature of – 35° C to – 40° C. This frozen product remains in good condition up to six months with flavour that is comparable with fresh product. The product is especially fine with spices (Padmanabhan, 1970).

UTILIZATION AND ECONOMIC IMPORTANCE OF CEPHALOPODS

Most of the squids cuttlefish and octopi are valued as food and bait in many parts of the world. Especially people of Japan, Korea, Mediterranean countries, Philippines, Malaysia, Indonesia and Taiwan extensively utilize cephalopods as food. In India only squids are relished to a large extent among the cephalopods. The meat of cephalopods is clean, attractive and has good flavour. It is also highly nutritive. The basic organic constituents of the squid meat and utility of the meat as human food from the point of view of digestibility and nutrition have been extensively studied by Japanese workers (Takahashi, 1960; Tanikawa and Suno, 1952). As a result it is considered that the squid meat may be a perfect source of protein (Takahashi, 1965). Generally the percentage yield of the edible portion of squid at 80 % of which the mantle forms 50 % and arms 30 %. The protein content of the squid is nearly 20 % wet weight which is in favourable comparison with commercially important fishes. The calorific value of the Japanese squid when seasoned is estimated at 117 cal / 100 g and the main constituents are crude protein 17·3 %, fat 1·83 % and carbohydrates 7·11 % wet wt (Tanikawa and Suno, 1952; Dracowich and Kelly, 1963).

The meat of cephalopods is prepared in many ways for food. Fresh meat is cut into slices and treated with spices and fried, or cooked into curries, cutlets or soup. In most of the preparations the white meat is sliced to frying size and well pounded before being cooked to render the flesh soft. In the Philippines the meat of squids and octopus is first boiled in vinegar with crushed garlic and then fried with oil and spices (Voss, 1963).

Cephalopods are used as bait. Cephalopods are utilized as biological material in neuro-physiological researches pertaining to the conduction of nerve impulses (Walford, 1958). Squids are used as manure (Clarke, 1963). The cuttlebones of cuttlefish are commercially valuable because of their calcium content. They are used in the preparation of abrasives and dentrifices (Dees, 1961). They are used in poultry and bird cages as a source of calcium and as grinding stone for beaks. Certain medicinal properties are also attributed to the bones and ink of cuttlefish (*vide* Boycott, 1957). The ink has been used by artists as a natural 'sepia' pigment in olden times. The pulvurized cuttlebones are used for rendering smooth the surface of wood-work and motor vehicles before they are painted. They are also used in jewellery making for moulding purposes.

Certain by-products such as oil and liver extract are also produced from squids, especially in Japan. The squid liver extract is used as human food and the same in condensed or dehydrated form serves as feed for live–stock (Takahashi, 1965). The viscera of squids is supposed to be ideal material as domestic poultry feed (Kawata *et. al.*, 1955). Cephalopods form an indirect source of another commercially much valued commodity, ambergris, which is widely used as a fixative in perfumery (Idyll, 1958). Ambergris is supposed to be formed directly from the sperm whales faeces adhering round horny beaks of squids (Lane, 1962).

At present in India squids and cuttlefish are largely fished to meet the domestic demand that exists mainly in coastal villages. Our annual production is meagre when compared with other well developed fisheries elsewhere. As shown in Table VII the annual landings of India for the period from 1959 to 1969 fluctuate between 94 tonnes in 1961 and 1515 tonnes in 1968. The average annual

TABLE VII

Cephalopod landings and their percentage in total marine landings in India from 1959 to 1968. Figures in tonnes. (C.M.F.R.I., 1969 a; 1969 b)

Year	Cephalopod landings	Total marine landings	Percentage of Cephalopods
1959	349	584587	0.05
1960	467	879681	0.05
1961	94	683569	0.01
1962	97	644244	0.01
1963	260	655484	0.03
1964	464	859582	0.05
1965	265	832777	0.03
1966	952	890311	1.00
1967	521	863879	0.06
1968	1515	902772	1.60
1969	769	913630	0.80

landings are estimated at 498 tonnes for the period. Cephalopod landings of different states are given in Table VIII. It is evident from the Table that Kerala and Maharashtra on the west coast and Tamil Nadu and Andhra on the east coast are the principal states that contribute higher percentages of landings. Though there seems to be no regular organised fishery for cephalopods on the west coast

TABLE VIII

State-wise and year-wise cephalopod landings during the period 1959 to 1968 in India. Figures in tonnes. (after C.M.F.R.I., 1969 a)

State	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
West Bengal & Orissa			6	12	1	5		1		19
Andhra	3	1		5	10	22		13	4	71
Madras		18	5	2	29	74	84	195	140	188
Kerala	288	417	28	17	180	340	174	714	374	1122
Mysore	15	14	1	7	13	1	1	1		13
Maharashtra	42	12	53	53	27	22	7	26	2	101
Gujarat				1		1	1	1	1	1
Goa	1	5	1					1		

the incidental catches amount to 82% of the total cephalopod catches (Table IX). There is good scope for India to increase cephalopod catches by exploiting the resources in the continental shelf and beyond it. Some of the potentially

TABLE IX

Cephaloped landings of the West and East coasts of India during 1959 to 1968. Figures in tonnes, (after C.M.F.R.I., 1969 a).

Year	West coast	East coast	Total
1959	346	3	349
1960	448	19	467
1961	83	11	94
1962	78	19	97
1963	220	40	260
1964	363	101	464
1965	183	82	265
1966	743	209	952
1967	377	144	521
1968	1237	278	1515

important species which occur in fair abundance in the Indian Ocean are *Symplectoteuthis oulaniensis, S. luminosa, Ommastrephes bartrami, Todarodes sagittatus* and *Notodarus sloanii*. Of these *S. oulaniensis* is the most abundant and predominantly distributed in the northern and central parts of the Indian Ocean and *O. bartrami* and *T. sagittatus* are distributed in the southern parts (Filippova, 1968).

There exists an export market for Indian cuttlebones. Cuttlebones are regularly reported to U.K., U.S.A. and Burma. For this purpose cuttlebones of *Sepia pharaonis* are preferred to others because of their larger size. The cuttlebones are exported through agents in Tuticorin. Before shipment the bones are well washed with soap water and perfectly dried. The chitinous edges of the bones are trimmed and quantities of such products are exported. Between 1963 and 1968 a total of 63,184 kg of cuttlebones valued at Rs. 2,41,431 have been exported from India (Table X).

TABLE X

Quantity and commercial value of cuttlebones exported from India between 1963 and 1968 (after C.M.F.R.I., 1969 a).

Year	Quantity of cuttlebones (Kg)	Value in Rupees
1963	421	11,139
1964	7,715	18,890
1965	7,968	37,184
1966	17,345	50,384
1967	2,507	25,783
1968	27,228	98,051
Total :	63,184	2,43,431
Average :	10,530	40,571

The present status of the world cephalopod fisheries is shown in Table XI. Annually about 0·9 million tonnes of squids, cuttlefish and octopi are landed. While cephalopods are caught almost in all maritime countries large scale fisheries are centered in North Pacific, especially in the seas around Japan and California, in the Mediterranean and in the North Atlantic. Japan has consistently been the world's largest producer of cephalopods contributing more than 75% annually to the world total cephaloped landings. Other important countries where large cephaloped fisheries exist are Korea, Spain, Italy, Philippines, China

TABLE XI

Cephalopod landings of different countries for the period 1963 to 1969 (landings in thousand tonnes) (after F.A.O., 1970a).

Country	1963	1964	1965	1966	1967	1968	1969
Japan	396·4	577·5	550·8	695·8	695·0	876·0	683·4
Korea	118·5	87·8	71·6	78·2	43·6	92·7	67·6
Spain	43·5	53·0	91·6	91·8	98·5	34·2	81·7
Italy	20·6	27·5	30·4	32·1	30·7	30·8	27·9
Philippines	6·8	7·6	10·0	11·4	9·9	17·9	13·1
China (Taiwan)	15·7	13·5	14·2	18·7	13·8	14·0	15·5
United States (Pacific)	5·2	7·5	8·4	8·7	9·0	11·5	9·4
United States(Atlantic)	2·2	1·0	1·2	1·2	1·8	1·7	1·7
Hongkong	1·9	1·5	1·4	2·4	1·7	2·5	3·8
Norway	0·5	1·5	10·8	2·5	1·9	0·1	–
England & Wales	0·1	0·1	0·1	0·1	0·1	0·1	0·2
Scotland	0·2	0·1	0·1	0·0	0·1	0·1	0·1
Canada (Atlantic)	2·4	10·8	7·9	5·1	7·0	0·0	0·0
Portugal	5·4	4·2	6·3	4·6	5·8	-	3·6
France	3·3	1·8	3·9	3·7	3·9	-	-

(Taiwan), U.S.A. and Canada. Japan exports huge quantities of cephalopods annually. She exported 7·1 thousand tonnes in 1969 to several countries like Malaysia, Philippines, Greece, Italy and Portugal (F.A.O., 1969b). Hongkong exports hundreds of tonnes of dried squids and cuttlefish to south-east Asian countries.

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